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Body Measurements and Proximate Analysis of Freshwater Crab (*Sudanonautes aubryi*) of Asejire Reservoir, Ibadan, Nigeria

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Abstract:
In this study, the interrelationships between various morphometric characters, viz., carapace width and length and chelae propodus length in males, as well as carapace width and length and abdominal width and length in females, were estimated using a total of 97 freshwater crabs (Sudanonautes aubryi). The allometric relationships between the characters of this set suggest that most relationships are positive and highly significant. The 'b' values for carapace width-weight in males and females were 3.008 and 2.973 respectively, and for carapace length-weight were 2.908 and 2.74, respectively. The results show a significant deviation from an isometric growth pattern in female S. aubryi. Other interrelationship between characters such as left and right chelae; abdominal length and abdominal width; carapace length and abdominal width; and other interrelationship showed significant correlation. The sex ratio was also determined with male as the dominant sex. The samples were subjected to proximate analysis. The moisture content recorded on the body fluid of S. aubryi are at an average of 76.45% in male and 75.08% in female, the crude fat which has a relatively low value of 13.57% for male and average of 14.55% in female, the ash contents obtained were very low with an average of 1.16% in male and 0.398% in female, the crude protein reported on the fluid of both male and female S. aubryi are 4.5% for male and 4.62% for female, Carbohydrate percentages available in S. aubryi has a relatively high value with an average of 3.83% for male and 5.36% for female.

Keywords: *crabs, Sudanonautes aubryi, morphometry, allometric relationships, proximate composition*

1. Introduction

There are about 1,300 described species of freshwater crabs, distributed throughout the tropics and subtropics and divided among eight families (Darren *et al*., 2008). They show direct development and maternal care of a small number of offspring, in contrast to marine crabs which release thousands of planktonic larvae (Darren *et al*., 2008). This limits the dispersal abilities of freshwater crabs, so they tend to be endemic to small areas. As a result, a large proportion is threatened with extinction.

Freshwater crabs found in the inland waters of Nigeria belong either to the genus *Sudanonautes* (Bott, 1955) or to the genus *Potamonautes* (Macleay, 1838). The former group inhabits streams or land close to water whereas the latter lives in major rivers (Cumberlidge, 1985).

Human consumption of freshwater crabs has been recorded from various parts of Africa, (Okafor, 1988; Cumberlidge, 1991). Crabs of the genera *Sudanonautes* and *Liberonautes* have been identified as secondary hosts of lung flukes (*Paragonimus* spp.), several species of which cause pulmonary paragonimiasis, in the rain forest regions of West and west-central Africa (Cumberlidge, 1999). The mode of transmission from crabs to humans is consumption of incompletely cooked crab flesh. Crabs may play a valuable role as indicators of pollution (Sanders *et al*., 1999; Shuwerack *et al*., 2001).

Shellfishes are nutritionally precious sources of various minerals and have high quality protein (Skonberg and Perkins, 2002). Crabs, among numerous other invertebrates are considered as an essential shell fishery product (Nalan and Yerlikayaa, 2003). Crustaceans constitute important nutritional component in the diet of rural and urban communities in Nigeria. The chemical composition and nutritional properties of aquatic crustaceans are important in their uses as sources of protein to significant proportion of the world population, particularly in developing countries where larger animal protein is expensive and beyond the reach of the poor man (Fasakin and Merce, 1992; Bello and Oke, 2006). It is reported that the crabs make up about 20% of all marine crustaceans caught worldwide; with an estimated 11.2 million tons of it being speculated to be consumed annually (Donaldson and Cullenberg, 1999). Documented information is scarce on the food value of most edible crabs in Western Nigeria despite the nutritive value of these crustacean. Most limnological studies are based on the physico-chemical qualities of water with regards to the species of fish found in

the aquatic ecosystem. Information on the proximate composition of crab species found in such ecosystems is scanty, despite the fact that they are considered as shell fish (Moronkola *et al*., 2011) and are therefore consumed by man as protein supplement. A selection of other documented works on proximate composition of crabs are; Adeyeye and Ogunlade (2006); Fagbuaro *et al*. (2014).

In crustaceans, as growth progresses, certain dimensions of the animal's body may grow much more than others, resulting in the phenomenon known as relative growth (Hartnoll, 1974). Studies of relative growth are often used to determine changes in the form and size of the body parts during ontogeny. Knowledge of these distinguishing characters and size relationships in sexually mature individuals is of particular importance in the study of commercially valuable crustaceans. Such knowledge can be useful for further studies on the life history of the species and in the development of its fishery, resource management, and culture. The mathematical length-weight relationship thus yields information on the general well-being of individuals, variation in growth according to sex and size at first maturity, gonadal development, and breeding season. Study of the length-weight relationship in aquatic animals has wide application in delineating the growth patterns during their developmental pathways (Bagenal, 1978).

According to Sudha-Devi and Sinija (2013), adult males were heterochelous whereas females exhibited both heterochely and isochely in almost equal proportions; sex ratio of the population significantly deviated from 1:1 with males outnumbering females. Other documented works on the study of the length-weight relationship in crabs are; Bello *et al*. (2009); Mady-Goma *et al*. (2014); Arimoro and Orogun (2008); Josileen (2011).

Though the morphometric details and nutritional composition of some species of crab have been partially described, there is paucity of information on the morphometric and nutritive composition of fresh water crab (*Sudanonautes aubryi*). Since crabs are good sources of nutrients in human diet in the face of animal protein scarcity, determining their morphometry and proximate composition of their body fluid will provide information on their relative growth and nutritional status in human diet.

2. Materials and Methods

2.1. Study Area

The Asejire Reservoir (07°21'45''N and 004°8'00''E) is in Oyo state, Nigeria on the Osun River, about 53 kilometers from Ile-Ife along Ife-Ibadan expressway.

2.2. Collection of Crab Specimens

A total of 97 crabs were collected between August – November, 2015 from the reservoir by employing the assistance of local fishermen. The specimens were placed in a cool box packed with ice and transported to the Animal Physiology Laboratory, Department of Zoology, Obafemi Awolowo University, Ile-Ife.

2.3. Morphometric Data

In the laboratory, using a digital vernier caliper, the Carapace Length (CL), Carapace Width (CW), Right Chelae Length (RCL), Left Chelae Length (LCL), Walking Legs (WL), Abdominal Width (AW) and Abdominal Length (AL) were determined to the nearest 0.01mm while the Body Weight (BW) was measured using electronic Stout Pro Balance (SPU 202) to the nearest 0.01g. Length/width - weight relationship was estimated in relation to sex, overall sex ratio was calculated. Fulton's condition factor was calculated monthly according to Bagenal (1978) with formula: $K = 100W/L^b$, where K = Condition factor, W = weight in grammes, L = carapace length and b = growth coefficient.

2.4. Proximate Composition Data

The body fluid was obtained by breaking the carapace using the dissecting set. Proximate composition of body fluid was carried out according to standard procedure of the Association of Official Analytical Chemist (AOAC, 2005). Moisture content was determined by drying the sample in an oven (Uniscope, SM9053, England) at 102-105 °C and dried to constant weight. Ash content was determined by incineration of 5 g of the sample at 600 °C in muffle furnace (Carbolite AAF1100, United Kingdom) for 8 hours. The determination of crude fat content was conducted by Soxhlet extraction method using n-hexane as solvent. Nitrogen content was determined using the Kjeldahl method and the quantity of protein was calculated by multiplying the percentage nitrogen content by the conversion factor 6.25 as described by Pearson (1976).

IBM SPSS®(version 22) and Microsoft Office® Excel 2016 were employed in the statistical analysis.

3. Results

A total of 97 freshwater crabs, *Sudanonautes aubryi* of both sexes (51 males and 46 females) were collected from Asejire Reservoir, and were analysed. Males carapace width (CW) ranged from 39.60 to 81.90mm (60.44 ± 1.2136mm) while the females' carapace width (CW) was between 36.07 and 73.66mm (58.13 ± 1.2903mm). The male and female carapace lengths (CL) ranged from 28.17 to 60.60mm (44.82 ± 0.8985mm) and 27.57 to 55.20mm (43.20 ± 1.0274mm) respectively. Body weight for male and female crabs ranged from 12.95 to 144.58 g (61.59 ± 3.8509 g) and from 12.00 to 97.44 g (51.90 ± 3.313 g) respectively (Table 1).

Allometric equations with respect to male and female *Sudanonautes aubryi* are shown in Tables 2 and 3. The allometric relations between the set of characters studied revealed that the relationships were positive and highly significant (Figures 1-9).

There was a strong positive correlation between carapace length (CL) and carapace width (CW) for male and female *S. aubryi* is (r = 0.98 and 0.97) respectively (Figure 1). There was a significant correlation between carapace length and carapace width for male (t = 34.041; p = 0.000) as well as for female (t = 27.43; p = 0.000).

3.1. Relationship between Left and Right Chelae Length
There was no correlation between right chelae and left chelae lengths in male crabs ($r = 0.00007$, $t = 0.057$, $p = 0.955$) but a weak correlation in female ($r = 0.2958$, $t = 4.299$, $p = 0.000$) (Figure2).

3.2. Relationship between Abdominal Width and Abdominal Length
A strong positive correlation was observed between abdominal length and abdominal width for both sexes ($r = 0.731$, $t = 11.533$; $r = 0.661$, $t = 9.269$; $p = 0.000$) (Figure 3).

3.3. Carapace Width and Abdominal Width
There was a significant correlation between carapace width and abdominal width for male ($r = 0.79$, $t = 8.922$, $p = 0.000$) and female ($r = 0.81$, $t = 9.131$, $p = 0.000$) (Figure 4).

3.4. Carapace Width and Abdominal Length
The correlation coefficient (r) was 0.78 for male and 0.95 for female. This indicated a strong positive correlation between carapace width and abdominal length in both sexes ($t = 8.614$; $t = 19.880$; $p = 0.000$) (Figure 5).

3.5. Carapace Length and Abdominal Width
Correlation coefficient (r) was 0.79 and 0.82 for male and female respectively, indicating very strong positive correlation between carapace length and abdominal width in both sexes ($t = 8.92$; $t = 9.52$; $p = 0.000$) (Figure 6).

3.6. Carapace Length and Abdominal Length
Carapace width – Abdominal length showed very strong positive correlation ($r = 0.80$, $t = 9.45$; $r = 0.93$, $t = 9.27$; $p = 0.000$) for males and females respectively (Figure 7).

3.7. Relationship between Carapace Length and Total Weight
Logarithmic transformation indicated a linear relationship between crab carapace length and body weight measurements. The relationship between Carapace length and Body weight is expressed as:
$\text{Log } W = \text{Log } a + b \text{ Log } L$
Scatter diagram was obtained by plotting log of body weight against log of carapace length of individual in both sexes (Figure 8). From the results presented, a distinct relationship of negative allometric growth pattern was found between carapace length and total weight. In males, the growth coefficient or exponential value ($b = 2.90$) for the carapace length-body weight relationship and ($b = 2.74$) in females. This indicated a deviation from the isometric growth pattern, ($b = 3$) in both sexes. The regression equations revealed high correlation coefficient values ($r = 0.9$) for male and ($r = 0.91$) for female.
$\text{LogW} = \text{Log }(-3.0326) + 2.9008 \text{ LogL}$ ………………. ($r^2 = 0.8101$, $N = 51$) for male
And $\text{LogW} = \text{Log }(-2.7979) + 2.740 \text{ LogL}$ ……………. ($r^2 = 0.8289$, $N = 46$) for female
(W = Body weight, L = Carapace length, N = Total number of each of male and female crabs examined).

3.8. Carapace Width and Total Body Weight
A logarithmic transformation showed that linear relationships existed between carapace length and body weight measurements. The relationships are expressed as:
$\text{Log } W = \text{Log } a + b \text{ Log } L_W$
Scatter diagram was obtained by plotting log of weight against log of carapace width for individual crabs in both sexes (Figure 9). A positive relationship was found between width and total weight. The growth coefficient also known as exponential value ($b = 3.008$) for male and ($b = 2.973$) for female for the carapace width-weight relationship showed that there was an isometric growth pattern, ($b = 3$). The regression equations revealed high correlation coefficient value $r = 0.92$ for male and 0.91 for female.
$\text{Log } W = \text{Log }(-3.6002) + 3.008 \text{ Log } L_W$ ………………… ($r^2 = 0.8434$, $N = 51$) for males
$\text{Log } W = \text{Log }(-3.5634) + 2.973 \text{Log } L_W$ …………………. ($r^2 = 0.8828$, $N = 46$) for females
W = Body weight, L_W= Carapace width.

3.9. Condition Factor (K)
Fulton's condition factor (K) is another measure of an individual shellfish's health that uses standard weight. It assumes that the standard weight of a Fish is proportional to the cube of its length:
$K = 100(W/L^b)$
Where W is the whole-body weight in grams; L is the length in centimetres; b is the growth coefficient and the factor of 100 is used to bring K close to a value of 1.
The individual 'K' for the length – weight relationship is shown in Table 4. The average mean of condition factor for the length – weight relationship and width – weight relationship indicate that the crabs are in very healthy state in their habitat ($k \geq 1$).

3.10. Sex Ratio

Between August and November, 2015; a total of 97 specimens were collected which included 51 males and 46 females, giving a sex ratio of 1 male to 0.9 females. There was no significant difference between male and female sex ratio (t = 0.53, p = 0.633, df = 3) (Table 5). 13 of the collected specimens were juveniles and 84 were adults giving a juvenile to adult ratio of 0.15 juveniles to 1 adult. Of the total juveniles collected, 4 were males and 9 were females and of the adults collected, 37 were females, 47 were males. The sample population was divided into juvenile male (4.12%), adult males (48.45%), and juvenile female (9.28%), adult female (38.14%).

3.11. Proximate Composition of Sudanonautes aubryi.

The proximate composition of the body fluid of male and female, *Sudanonautes aubryi* are presented in Figures 10 and 11.

- Moisture Content: The monthly moisture content recorded were 78.89, 78.76, 76.28 and 73.85% in male; and 79.19, 74.71, 74.39 and 72.04% in female between August and November respectively. The values decreased from August to November. It was highest in August and lowest in November for males and females.
- Crude Fat: Crude fat recorded were 10.07, 13.27, 14.99 and 15.95% for male while those of female were 11.11, 14.30, 15.79 and 16.98% in August, September, October and November respectively. The values increased from August to November with lowest and highest figures in August and November respectively.
- Ash Content: Ash content recorded were 0.13, 0.49, 1.12 and 2.89% for male and 0.10, 0.13, 0.17 and 1.19% for females in August, September, October and November respectively. The values increase from August to November. It was lowest in August and highest in November.
- Crude Protein: Crude protein recorded were 3.99, 4.31, 4.65 and 5.05% for male and 3.65, 4.54, 4.59 and 5.69% for females in August, September, October and November respectively. The values increased from August to November. It was lowest in August and highest in November.
- Carbohydrate: The percentage quantity of Carbohydrate in male were 6.92, 3.17, 2.96 and 2.26% for male and those in female were 6.32, 5.95, 5.06 and 4.10% in August, September, October and November respectively. The values decreased from August to November. It was highest in August and lowest in November.

4. Discussion

The morphometric profile of *Sudanonautes aubryi* such as length of the chelae, carapace width, abdominal width and abdominal length, body weight and walking legs length determined in this study probably provide one of the useful tools for taxonomic study of freshwater crabs. Apart from Cumberlidge (1994) and Mady-Goma *et al.* (2014) studies on morphometric studies of the crabs *Sudanonautes aubryi*, the present study is a new addition to morphometric study of *Sudanonautes aubryi* from Asejire reservoir, southwest Nigeria. The results will be useful in comparing the different stocks of the same species at different geographical locations.

The mean carapace width of male and female were 60.44 ± 1.2136mm and 58.13 ± 1.2902mm with no significant difference between them (p>0.05). There was also no significant difference in the body weight of male (61.59 ± 3.8509) g and female (51.89 ± 3.3130) g (p> 0.05). The result was compared with Bello *et al.* (2009) studies on *Sudanonautes africanus* whose weight ranged of 50 – 175 g and Atar and Secer (2003) who recorded 8.92 – 448 g for *Callinectes sapidus* indicating that marine crabs are heavier than freshwater crabs.

The adult size of *S. aubryi* from Asejire Reservoir was between 50 - 82 mm in this study. It was higher than the 45 – 50 mm reported by Cumberlidge (1994) for the carapace width and this was smaller than the *S. aubryi* specimen found in Congo River which had a cephalothorax width of 90mm and higher than 42.35mm reported by Mady-Goma*et al.* (2014). The cephalothorax width of male is higher than female with a minimum of 39.60mm in males and 36.07mm in female but not significantly different, (t = 2.169; p = 0.035; df = 45). The correlation coefficient (r) determined from regression for males and females are 0.9795 and 0.9720 respectively which was similar to 0.97 reported by Mady-Goma *et al.* (2014).

Linear relationship observed in the present study indicates corresponding increases in carapace length and body weight relationship (LWR). The carapace length-weight relationship of *Sudanonautes aubryi* indicates negative deviation from isometric growth pattern which was more pronounced in females (b = 2.74) than males (b = 2.90) and the carapace width-weight relationship was isometric (b = 3.008 for males and b = 2.973 for females). This result was compared with Bello *et al.* (2009) who recorded (b = 2.475 for males and b = 3.185 for females) in *Sudanonautes africanus* for carapace length-weight relationship (LWR). The present result was also compared to Josileen (2011) exponential values (b) for carapace length-weight (LWR) in males and females *Portunus pelagicus* (b = 3.049 and 2.774, respectively) indicating that there is significant departure from isometric growth which is only evident in females and for the carapace width-weight relationship in males and females (b = 3.607 and 3.293, respectively) this also shows that there is marked deviation from the isometric growth pattern.

The growth coefficient (b) values have some implications and significant impacts on the well-being of fishes (including shell fish) and its fishery. The negative allometry (b < 3) means the crabs were light for their body length. Fish with positive allometry (b > 3) values are heavy for their lengths, (Wootton, 1998). The change of *b* values depends primarily on the shape and fatness of the species, seasons or time of the years, temperature, salinity, food (quantity, quality and size), individual metabolism, sex and stage of maturity (Morey *et al*., 2003; Henderson, 2005; Ozaydin & Taskavak, 2007).

The mean condition factor (K), for male was 75.28 and 89.31gcm^{-3} for females showed that female crabs exhibited a better wellbeing than the males in Asejire Reservoir. This could be as a result of competition by male for female thus expending much energy (which could have been useful for growth and development) in the process. This is in contrast with Bello *et al.* (2009) who reported K values

of 33.91 and 30.09 in male and female *S. africanus* crabs. Atar and Secer (2003) using blue crab, *C. sapidus,* recorded condition factor values 48.196 for males and 5.638 for females. Warner (1977) also reported that in true crabs, the males showed higher condition factor than the females.

Like growth coefficients, K has impacts on the well-being of some aquatic organisms. It varies from species to species, and changes according to morphology, sex, age, reproductive state associated with gonadic maturity stages variations (Wootton, 1999). Variations in K may also be indicative of food abundance, adaptation to environment and gonadal development of fish (King, 1995). Low K values means the crabs are light for their lengths, and indication of low feeding intensity and spawning activity. High K value is an assumption of high feeding intensity and gradual increase in accumulated fat that also suggests preparation for a new reproductive period (Braga and Gennari-Filho, 1990).

Sex ratio in the present study showed male as the dominant sex (51 males to 46 females; 1:0.9). This is in agreement with Mady-Goma *et al.* (2014) who reported sex distribution of 115 males to 71 females with ratio of 1:0.62. However, the present study revealed more juvenile females than males (9 females to 4 males; 1:0.44) which contrasted from what Mady-Goma *et al*. reported of 1:0.29 juvenile male to juvenile female.

The chemical composition analysis of the body fluid of *S. aubryi* revealed variable nutritional fluid contents. The moisture content recorded on the body fluid of *S. aubryi* are at an average of 76.45% in male and 75.08% in female. This was similar to the average value of 76.89% reported in *Callinectes sapidus* and 76.72% reported in sea bream (*Sparus aurata*) which may be attributed to the influence of the season and water temperature (Nuray and Ozkan, 2007). High moisture contents in organisms are considered as an advantage because of its contribution in the stabilization of the organism during movements (Eddy *et al.,* 2004).

The crude fat which followed moisture content has a relatively low value of 13.57% for male and average of 14.55% in female. This result was very high when compared to the (0.50 ± 0.86% and 0.95 ± 0.08%) for parts analysed by Usman (2015) for *Sudanonautes kagoroensis* and also higher than that obtained in *Callinectes amnicola* which averaged between 0.002 ± 0.001% and 0.060 ± 0.050% (Moronkola *et al.*, 2011). The quantity of fat determined in this study for freshwater crab is on the high side compared to marine crabs. This result was somewhat a bit lower to what was reported for pangas fish (*Pangasianodon hypophthalmus*) in laboratory condition of (16.55 ± 1.52) % by Begum *et al.* (2012). Crabs have been reported to show low calories than pork, beef and the poultry (Broughton *et al*., 1997). Fats are noted to be highly efficient sources of energy and they contain more than twice the energy of carbohydrate and proteins. Fats serve as source of metabolic energy, but also indispensable in maintaining cellular integrity. Females of *S. aubryi* had higher percentage of fat hence serves as higher food reservoir along with protein. The percentage storage of fat in crabs is subject to periodic fluctuations influenced by environmental variables like temperature (Nagabhushaman and Farooqui, 1982).

Ash content of *S. aubryi* is an indication of mineral concentration in the organism (Eddy *et al.,* 2004 and FAO, 2005). The ash contents obtained were very low with an average of 1.16% in male and 0.398% in female. The present study is in line with Usman (2015) who reported between 1.04 ± 0.58% and 1.21 ± 0.083% for ash content in *S. kagoroensis* for all the parts analyzed. This is also in line with the average ash content 1.040 ± 0.017% and 1.300 ± 0.001% for *Callinectes amnicola* (Moronkola *et al*., 2011). The difference in ash content between the sexes could be related to their body sizes at the time of collection and seasonal changes of the environment.

The crude protein reported on the fluid of both male and female *S. aubryi* are on the low side of 4.5% for male and 4.62% for female. This result was lower compared to what Usman (2015) reported which contained a good level of protein (12.08 ± 0.58% – 24.96 ± 0.78%) and also lower than the average protein content 19.233 ± 0.066% and 28.00 ± 0.071% obtained in *Callinectes amnicola* (Moronkola *et al*., 2011). The protein content of the crabs has been supported by the sizes at the time of collections, lack of pollution and other environmental factors, food availability, etc. The protein is known to be essential for the sustenance of life (Okuzumi and Fujii, 2000).

Carbohydrate percentages available in *S. aubryi* has a relatively high value with an average of 3.83% for male and 5.36% for female compared to that of Varadharajan and Soundarapandian (2014), which ranged between 0.85 ± 1.10% to 0.34 ± 0.10% for freshwater crab *Spiralothelphusa hydrodroma*. The present study was similar to that which was reported by Elegbede and Fashina (2013) of (5.40 ± 0.00) % and (7.13 ± 0.09) % for *Callinectes pallidus* and *Cardisoma armatum* respectively.

5. Conclusion

This study revealed that crab, *S. aubryi* from Asejire reservoir exhibited variations in their growth patterns and sex ratios. In addition, the present study has provided useful information on aspects of the biology of crab, *S. aubryi* which will be useful in fisheries biology and management; and shellfish population dynamics and stock assessment of the resource species. *S. aubryi* contain sufficient nutrients and minerals that are beneficial to humans as food and in farmed animals' nutrition. The consumption of (*S. aubryi*) could therefore serve as alternatives to cat fishes, mackerel and poultry where they are not readily available.

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Annexure

	Male (N = 51)				Female (N = 46)			
Characteristics	**Minimum Value**	**Maximum Value**	**Mean**	**Std. Error of Mean**	**Minimum Value**	**Maximum Value**	**Mean**	**Std. Error of Mean**
Carapace Width (CW) (mm)	39.60	81.90	60.4449	1.21355	36.07	73.66	58.1328	1.29025
Carapace Length (CL) (mm)	28.17	60.60	44.8206	0.89847	27.57	55.20	43.1978	1.02739
Body Weight (BW) (grams)	12.95	144.58	61.5949	3.85087	12.00	97.44	51.8996	3.31297
Right Chelae Length (RCL) (mm)	0.00	112.49	62.4349	4.23005	0.00	82.22	52.3991	4.14147
Left Chelae Length (LCL) (mm)	0.00	95.27	59.4429	3.38240	0.00	80.07	50.9541	3.99049
Walking Leg 1 (WL_1) (mm)	0.00	80.10	57.0773	2.31436	0.00	76.59	49.5380	3.10576
Walking leg 2 (W_2) (mm)	0.00	89.58	65.4043	2.14827	0.00	78.39	50.7385	4.14522
Walking Leg 3 (WL_3) (mm)	0.00	87.28	54.4875	4.36524	0.00	79.03	59.3530	3.27395
Walking Leg 4 (WL_4) (mm)	0.00	77.48	50.6667	3.04493	0.00	66.82	40.8509	3.94879
Abdominal Length (AL) (mm)	17.10	44.95	30.9533	0.75978	17.56	61.08	40.9987	1.57430
Abdominal Width (AW) (mm)	13.01	28.00	19.2094	0.40072	0.00	40.76	27.7993	1.37112

Table 1: Measurements of Morphometric Characters of male and female S. aubryi

Independent Variable (x)	**Dependent Variable (y)**	**Allometric Growth Equation (y = a + bx)**	**'r^2' Value**
Carapace Length (CL)	Carapace Width (CW)	CW =1.1469 + 1.323CL	0.9594
Right Chelae Length (RCL)	Left Chelae Length (LCL)	LCL= 59.036 + 0.0065RCL	0.00007
Abdominal Length (AL)	Abdominal Width (AW)	AW = 5.2536 + 0.4509AL	0.7308
Carapace Length (CL)	Body Weight (BW)	BW = -108.68 + 3.7991CL	0.7857
Carapace Width (CW)	Body Weight (BW)	BW = -113.83 + 2.9022CW	0.8365
Carapace Width (CW)	Abdominal Width (AW)	AW= 3.5064 + 0.2598CW	0.619
Carapace Width (CW)	Abdominal Length (AL)	AL = 1.5839+ 0.4859CW	0.6023
Carapace Length (CL)	Abdominal Width (AW)	AW = 3.4835+ 0.3509CL	0.6189
Carapace Length (CL)	Abdominal Length (AL)	AL= 0.4954+ 0.6796CL	0.6458
Abdominal Width (AW)	Abdominal Length (AL)	AL= - 0.1815+ 1.6208AW	0.7308

Table 2: Allometric equations and r^2 values between morphometric variables of male S. aubryi

Independent Variable (x)	**Dependent Variable (y)**	**Allometric Growth Equation (y = a + bx)**	**'r^2' Value**
Carapace Length (CL)	Carapace Width (CW)	CW =5.4032+ 1.2207CL	0.9447
Right Chelae Length (RCL)	Left Chelae Length (LCL)	LCL= 23.496+0.524RCL	0.2958
Abdominal Length (AL)	Abdominal Width (AW)	AW= - 1.2386+ 0.7083AL	0.6613
Carapace Length (CL)	Body Weight (BW)	BW = - 70.84 + 2.8413CL	0.7764
Carapace Width (CW)	Body Weight (BW)	BW = - 84.334 + 2.3435CW	0.833
Carapace Width (CW)	Abdominal Width (AW)	AW= - 22.181+ 0.8598CW	0.6546
Carapace Width (CW)	Abdominal Length (AL)	AL = - 26.286+ 1.1574CW	0.8998
Carapace Length (CL)	Abdominal Width (AW)	AW = - 19.508+ 1.0951CL	0.6734
Carapace Length (CL)	Abdominal Length (AL)	AL= - 20.552+ 1.4249CL	0.8646
Abdominal Width (AW)	Abdominal Length (AL)	AL= 15.042+ 0.9337AW	0.6613

Table 3: Allometric equations and r^2 values between morphometric variables of female Sudanonautes aubryi

Sex	Relationship	Minimum 'K' Value (gcm^{-3})	Maximum 'K' Value (gcm^{-3})	Mean OF 'K' Value (gcm^{-3})
Males	Length – Body weight	32.4170	102.8631	75.2765
	Width – Body weight	14.4651	32.4941	25.9962
Females	Length – Body weight	51.9593	127.6465	89.3103
	Width – Body weight	15.4339	32.9404	26.0441

Table 4: Condition factor 'K' for the length/width – weight relationships for male and female Sudanonautes aubryi

Month	Male	Female	Male: Female (Sex Ratio)
August	11	10	1:0.91
September	12	14	0.86:1
October	19	11	1:0.58
November	9	11	0.82:1
Total	51	46	1:0.9

Table 5: Monthly sex ratio of Sudanonautes aubryi

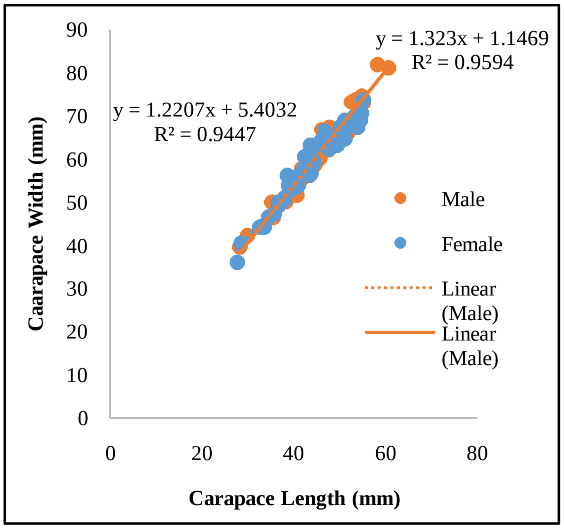

Figure 1: Carapace width – Carapace length relationship in male and female Sudanonautes aubryi.

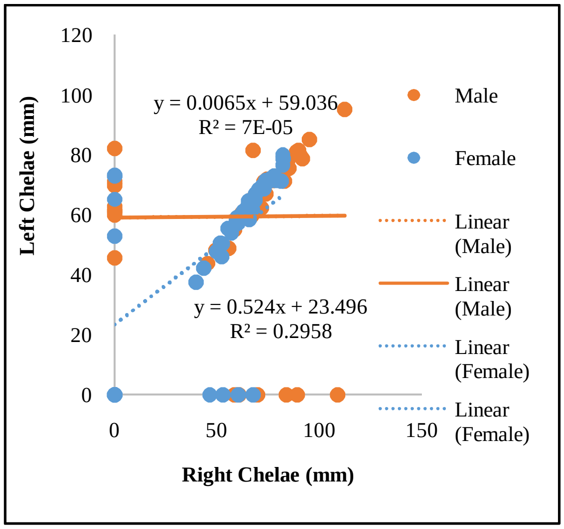

Figure 2: Left chelae length – Right chelae length relationship in male and female Sudanonautes aubryi.

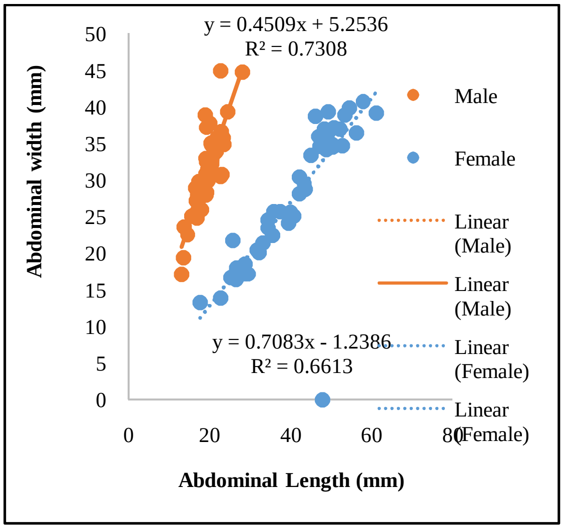

Figure 3: Abdominal width – Abdominal length relationship of male and female Sudanonautes aubryi.

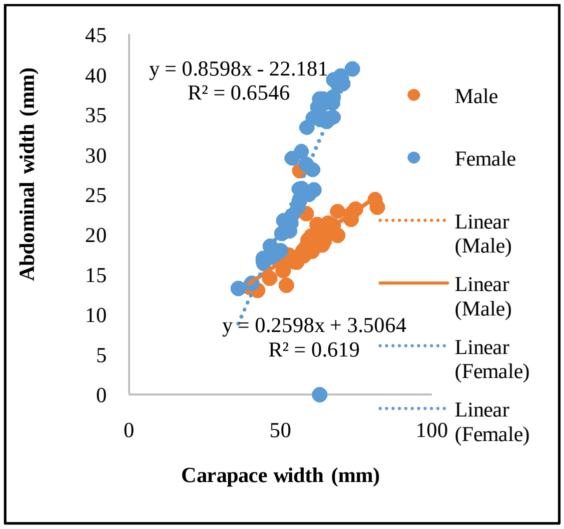

Figure 4: Abdominal width - Carapace width relationship in male and female Sudanonautes aubryi.

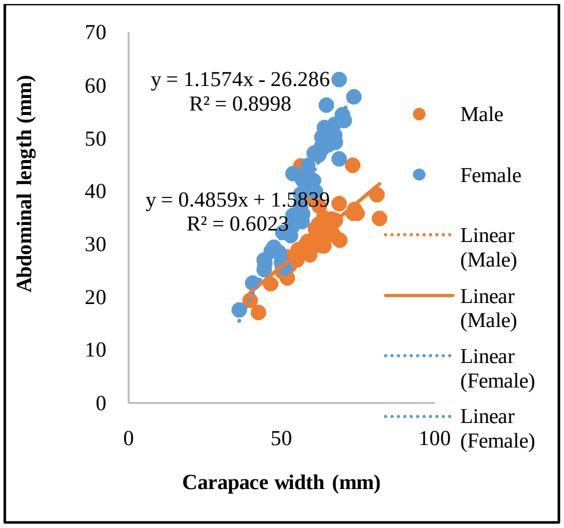

Figure 5: Abdominal length - Carapace width relationship in male and female Sudanonautes aubryi.

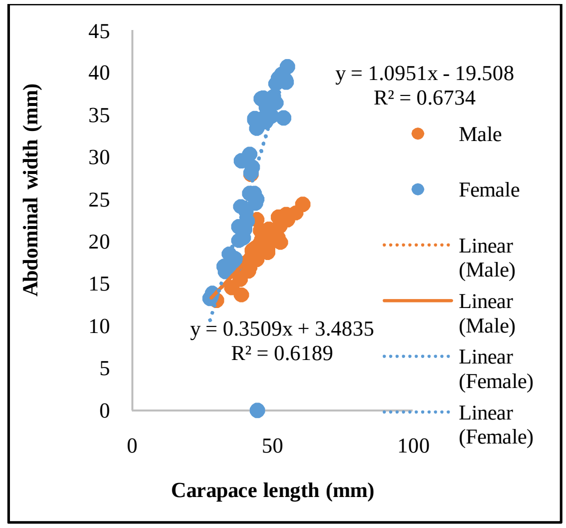

Figure 6: Abdominal width - Carapace length relationship in male and female Sudanonautes aubryi.

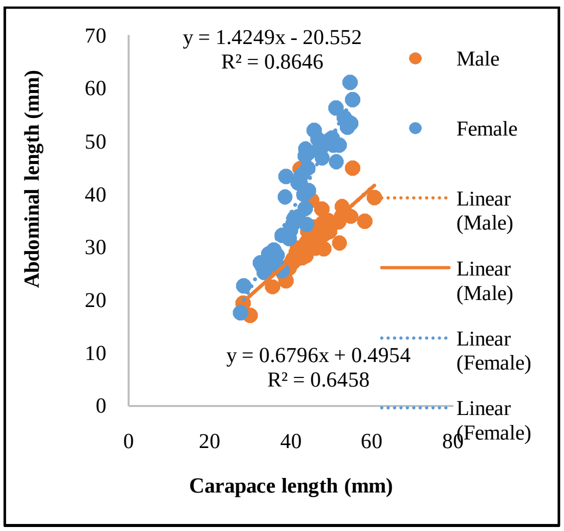

Figure 7: Abdominal length - Carapace length relationship in male and female Sudanonautes aubryi.

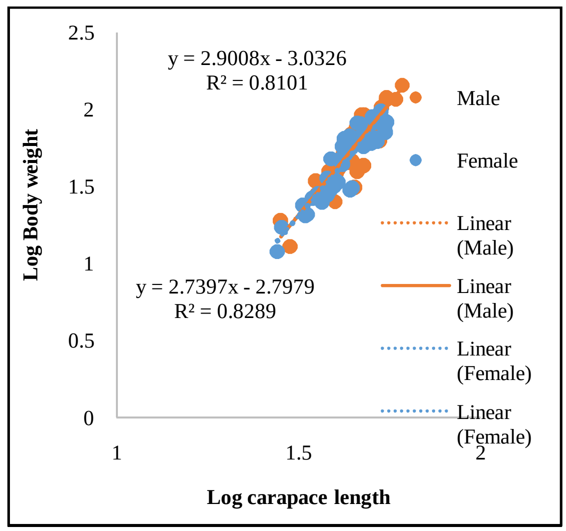

Figure 8: Plot of Log of Body weight against Log ofCarapace length for male and female Sudanonautes aubryi.

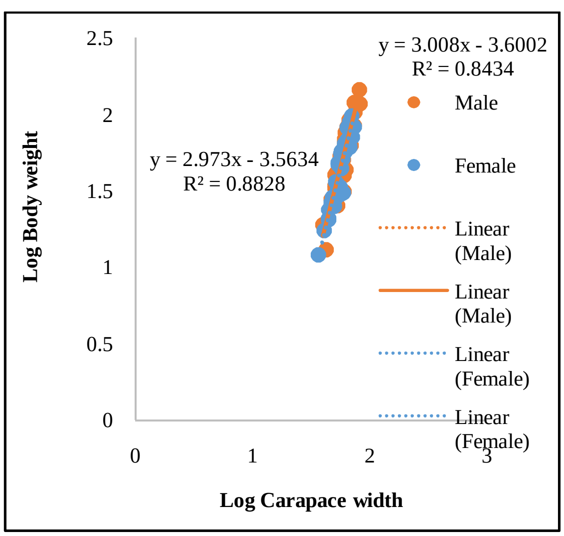

Figure 9: Log of total weight against log of width in male and female Sudanonautes aubryi

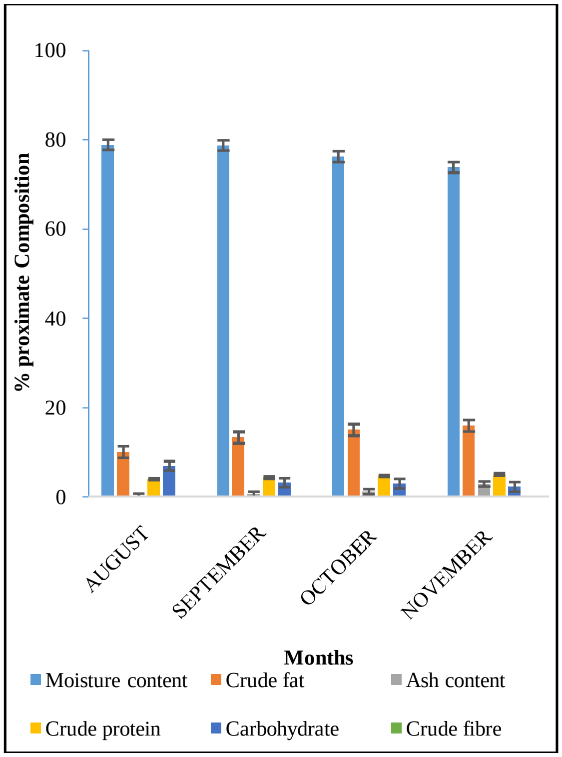

Figure 10: Percentproximatecomposition of male Sudanonautes aubryi

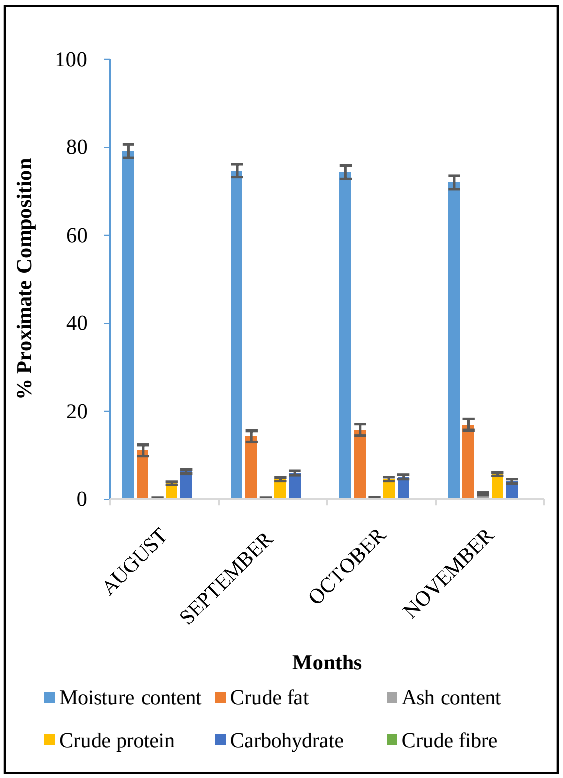

Figure 11: Percent proximate composition of female Sudanonautes aubryi